High Accuracy Dual Low Dropout Linear Regulator

PRELIMINARY DATA

ADP3304*

FEATURES
High Accuracy: 0.5%
Low Ground Current
Separate Grounds
Extreme Low Dropout Voltage: 100mV Typical
Requires only C_o = 0.47µF for Stability
Current and Thermal Limiting
Low Noise
3.0 V to 20 V Supply Range
-40°C to +125°C Junction Temperature Range
Low Current Shutdown: 1 µA
Several Fixed Voltage Options
Thermally Enhanced SO8 Package

APPLICATIONS
Cellular Telephones
Notebook and Palmtop Computers
Battery Powered Systems
Portable Instruments
High Efficiency Linear Regulators

GENERAL DESCRIPTION

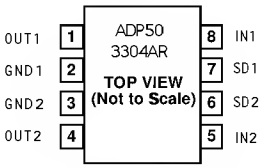
The ADP3304 is a member of the ADP330X family of precision micropower low dropout regulators. The ADP3304 contains two fully independent 100 mA regulators with separate shutdown and ground pins. It features 1% overall output accuracy and very low 100mV typical dropout voltage.

The ADP3304 has a wide input voltage range from 3 V to 20 V. It has short circuit current protection as well as thermal shutdown.

The ADP3304 enhanced lead frame design allows for a maximum power dissipation of 630 mW @ 70°C ambient temperature and 1.15 W at room temperature without any external heat sink.

***Patent pending.**

PIN CONFIGURATION

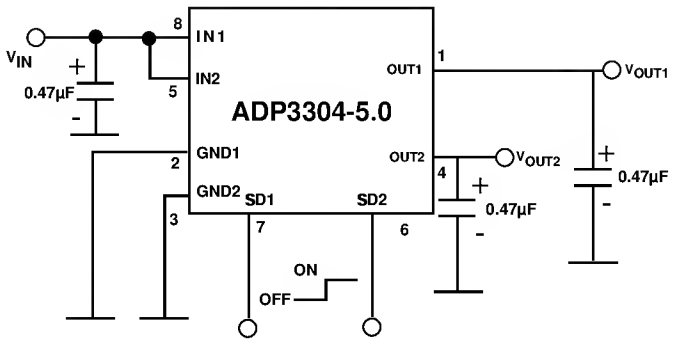


SOIC PIN CONFIGURATION
FOR 5V DEVICE

ORDERING INFORMATION

Model	Voltage Outputs		Package Option*
ADP3304AR-2.7	OUT 1	2.7	SO-8
ADP3304AR-5	OUT 2	5.0	SO-8
ADP3304AR-3	OUT 1	3.0	SO-8
ADP3304AR-3	OUT 2	3.0	SO-8
ADP3304AR-3.3	OUT 1	3.3	SO-8
ADP3304AR-3.3	OUT 2	3.3	SO-8
ADP3304AR-3.3	OUT 1	3.3	SO-8
ADP3304AR-5	OUT 2	5.0	SO-8

NOTE: T_J Temperature Range: -40°C to +125°C
*SO = Small Outline Package
Customized Options are also Available with Mixed Output Voltages



ADP3304 Application Circuit

COMPANY CONFIDENTIAL

ALL DATA SUBJECT TO CHANGE

REV.D, 8/29/96

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ADP3304-XX - SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@T_J = -40°C to +125°C, V_{IN} = 7V ,C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
GROUND CURRENT	I_{GND1}& I_{GND2}	I_{L1} = I_{L2}= 100 mA I_{L1} = I_{L2} = 0.1 mA		2 0.25	4 0.5	mA mA
GROUND CURRENT IN DROPOUT	I_{GND1} & I_{GND2}	V_{IN} = 2.5 V I_L = 0.1 mA		0.2	0.4	mA
DROPOUT VOLTAGE	V_{DROP}	I_L = 100 mA I_L = 10 mA I_L = 1 mA		0.1 0.05 0.02	0.2 0.1 0.05	V V V
SHUTDOWN THRESHOLD	V_{THSD}	ON OFF	1.5	0.9 0.9	 0.3	V V
SHUTDOWN PIN INPUT CURRENT	I_{SDIN}	0 < V_{SD} < 5 V 5 ≤ V_{SD} ≤ 20 V		0	1 100	µA µA
GROUND CURRENT IN SHUTDOWN MODE	I_Q	V_{SD1} = V_{SD2} = 0, T_J = +25°C GND1 or GND2 T_J = +125°C			± 1 ± 5	µA µA
OUTPUT CURRENT IN SHUTDOWN MODE	I_{OSD}				10	µA
SHORT CIRCUIT OUTPUT CURRENT	I_{OSC}		120		250	mA
THERMAL REGULATION	$\frac{\Delta V0}{V0}$	V_{IN} = 20 V I_L = 100mA T = 10msec		0.05	0.2	%/W
OUTPUT NOISE	V_{NOISE}	f = 10 Hz-100 kHz		100		μV_{RMS}
OUTPUT IMPEDANCE	Z_{OUT}	f = 10 Hz to 1 MHz		0.1		Ω

For specifications of other output voltage options, please request copy of full data sheet.
Specifications subject to change without notice.
All limits at temperature extremes are guaranteed via correlation using standard statistical methods.

ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage . . . . . -0.3 to +22 V
Shutdown Input Voltage . . . . . -0.3 to +22 V
Thermal Protection . . . . . 165°C
Output Short Circuit . . . . . Protected
Power Dissipation . . . . . Internally Limited
θ_{JA} . . . . . 87°C/W
θ_{JC} . . . . . 41°C/W
Operating Junction Temperature Range . . . . -40°C to +125°C
Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature Range (Soldering 10 sec) . . . . . +300°C
Vapor Phase (60 sec) . . . . . +215°C
Infrared (15 sec) . . . . . +220°C

NOTES
*This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
θ_{JA} is specified for worst case conditions with devices soldered on a circuit board.

ADP3304-2.7 - SPECIFICATIONS

ELECTRICAL CHARACTERISTICS ($@T_J$ = -40°C to +125°C, V_{IN} = 3.0V, C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.0 V to 20 V I_L = 0.1 mA to 100 mA T_J = 25°C,	2.686	2.7	2.714	V
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.0 V to 20 V I_L = 0.1 mA to 100 mA	2.673	2.7	2.727	V
LINE REGULATION	$\frac{\Delta V_O}{\Delta V_{IN}}$	V_{IN} = 3.0 V to 20 V T_J = 25°C		0.1		mV/V
LOAD REGULATION	$\frac{\Delta V_O}{\Delta I_L}$	I_L = 0.1 mA to 100 mA T_J = 25°C		0.1		mV/mA
CROSS-REGULATION	$\frac{\Delta V_{O1}}{\Delta I_{L2}}$ or $\frac{\Delta V_{O2}}{\Delta I_{L1}}$	I_L= 0.1 mA to 100 mA T_J = 25°C		25		µV/mA

ADP3304-3.0 - SPECIFICATIONS

ELECTRICAL CHARACTERISTICS ($@T_J$ = -40°C to +125°C, V_{IN} =3.3V, C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.3 V to 20 V I_L = 0.1mA to 100 mA T_J = 25°C	2.985	3	3.015	V
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.3 V to 20 V I_L = 0.1 mA to 100 mA	2.97	3	3.03	V
LINE REGULATION	$\frac{\Delta V_O}{\Delta V_{IN}}$	V_{IN} = 3.3 V to 20 V T_J = 25°C		0.1		mV/V
LOAD REGULATION	$\frac{\Delta V_O}{\Delta I_L}$	I_L = 0.1 mA to 100 mA T_J = 25°C		0.1		mV/mA
CROSS-REGULATION	$\frac{\Delta V_{O1}}{\Delta I_{L2}}$ or $\frac{\Delta V_{O2}}{\Delta I_{L1}}$	I_L= 0.1 mA to 100 mA T_J = 25°C		25		µV/mA

ADP3304-3.2 - SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@T_J = -40°C to +125°C, V_{IN} = 3.5V ,C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.5 V to 20 V I_L = 0.1 mA to 100 mA T_J = 25°C	3.184	3.2	3.216	V
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.5 V to 20 V I_L = 0.1 mA to 100 mA	3.168	3.2	3.232	V
LINE REGULATION	$\frac{\Delta V_O}{\Delta V_{IN}}$	V_{IN} = 3.5 V to 20 V T_J = 25°C		0.1		mV/V
LOAD REGULATION	$\frac{\Delta V_O}{\Delta I_L}$	I_L = 0.1mA to 100mA T_J = 25°C		0.1		mV/mA
CROSS-REGULATION	$\frac{\Delta V_{O1}}{\Delta I_{L2}}$ or $\frac{\Delta V_{O2}}{\Delta I_{L1}}$	I_L= 0.1mA to 100mA T_J = 25°C		25		µV/mA

ADP3304-3.3 - SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@T_J = -40°C to +125°C, V_{IN} = 3.6V ,C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.6 V to 20 V I_L = 0.1 mA to 100 mA T_J = 25°C	3.283	3.3	3.317	V
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 3.6 V to 20 V I_L = 0.1 mA to 100 mA	3.267	3.3	3.333	V
LINE REGULATION	$\frac{\Delta V_O}{\Delta V_{IN}}$	V_{IN} =3.6 V to 20 V T_J = 25°C		0.1		mV/V
LOAD REGULATION	$\frac{\Delta V_O}{\Delta I_L}$	I_L = 0.1 mA to 100 mA T_J = 25°C		0.1		mV/mA
CROSS-REGULATION	$\frac{\Delta V_{O1}}{\Delta I_{L2}}$ or $\frac{\Delta V_{O2}}{\Delta I_{L1}}$	I_L= 0.1 mA to 100 mA T_J = 25°C		25		µV/mA

ADP3304-5.0 - SPECIFICATIONS

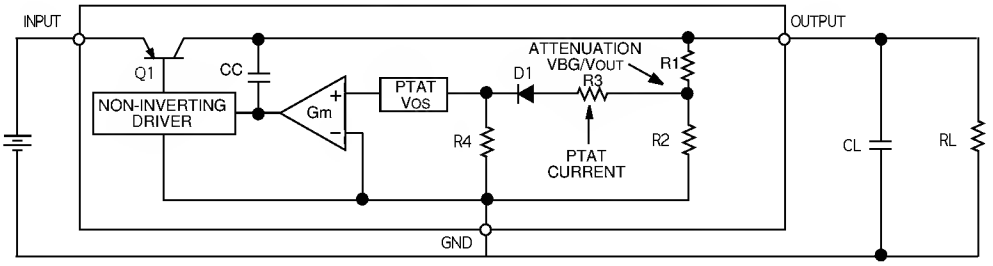
ELECTRICAL CHARACTERISTICS ($@T_J$ = -40°C to +125°C, V_{IN} =5.3V ,C_{IN} = 0.47µF, C_{OUT} =0.47µF, unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 5.3 V to 20 V I_L = 0.1 mA to 100 mA T_J = 25°C	4.975	5.0	5.025	V
OUTPUT VOLTAGE	V_{OUT1} or V_{OUT2}	V_{IN} = 5.3 V to 20 V I_L = 0.1 mA to 100 mA	4.95	5.0	5.05	V
LINE REGULATION	$\frac{\Delta V_O}{\Delta V_{IN}}$	V_{IN} =5.3 V to 20 V T_J = 25°C		0.1		mV/V
LOAD REGULATION	$\frac{\Delta V_O}{\Delta I_L}$	I_L = 0.1 mA to 100 mA T_J = 25°C		0.1		mV/mA
CROSS-REGULATION	$\frac{\Delta V_{O1}}{\Delta I_{L2}}$ or $\frac{\Delta V_{O2}}{\Delta I_{L1}}$	I_L= 0.1 mA to 100 mA T_J = 25°C		25		µV/mA

PIN DESCRIPTION (ADP3304)

Pin	Name	Function
1	OUT1	Output of Regulator 1, fixed 2.7, 3.0, 3.2, 3.3 or 5 volts output voltage. Sources up to 100 mA. Bypass to ground with a 0.47µf capacitor.
2	GND1	Ground Pin.
3	GND2	Ground Pin.
4	OUT2	Output of Regulator 2, independent of the regulator 1. Fixed 2.7, 3.0, 3.2, 3.3 or 5 volts output voltage. Bypass to ground with a 0.47 µf capacitor.
5	IN2	Regulator 2 Input. Supply voltage can range from 3.0 V to 20 V.
6	SD2	Active Low Shutdown Pin for Regulator 2. Connect to ground to disable the regulator 2 output. When shutdown is not used, this pin should be connected to the input pin.
7	SD1	Shutdown Pin for Regulator 1, otherwise identical to SD2.
8	IN1	Regulator 1 Input. Supply voltage can range from 3.0 V to 20 V.

ADP3304 FUNCTIONAL BLOCK DIAGRAM (1/2 IS SHOWN)



APPLICATION INFORMATION

The ADP3304 is very easy to use. The only external component required for stability is a small 0.47 µf bypass capacitor on the outputs. If the shut-down feature is not used, shut-down pin (pin 5) should be tied to the input pin.

OUTPUT CURRENT LIMITING

Short circuit protection is provided by limiting the pass transistors base drive current. Maximum output current is limited to 400 mA.

THERMAL OVERLOAD PROTECTION

The ADP3304 is protected against damage due to excessive power dissipation by its thermal overload protection circuit which limits the die temperature to a maximum of 165°C. Under extreme conditions (i.e., high ambient temperature, very high input voltage and maximum load current) where die temperature starts to raise, the output current is abruptly reduced until die temperature is dropped to a safe level. The output current is restored when die is cooled down.
Current limit protection and thermal limit protection are intended to protect the device against current overload conditions at the output of the device. For normal operation, device power dissipation should be externally limited so that junction temperatures will not exceed 125°C.

CALCULATING JUNCTION TEMPERATURE

Device power dissipation is calculated as follows :

$Pd = (V_{IN}-V_{OUT1}) I_{Load1} + (V_{IN}-V_{OUT2}) I_{Load2} + (V_{IN}) I_{GND}$

Where I_{Load1} and I_{Load2} are Load currents on outputs 1 & 2, IGND is ground current, V_{IN} and V_{OUT} are input and output voltages respectively.

Assuming $I_{Load1}=I_{load2}$=100 mA, IGND= 2 mA, V_{IN} = 9 V and $V_{OUT1}=V_{OUT2}$ = 5.0 V, device power dissipation is:

Pd = (9 V - 5 V) 100 mA + (9V - 5V) 100 mA +(9V) 2 mA = 0.818 W

The proprietary package used in ADP3304 has a thermal resistance of 87°C/W which is significantly lower than a standard 8 pin SOIC package at 170°C/W.

Junction temperature rise above ambient temperature will be approximately equal to :

0.818W x 87°C/W = 72°C

To limit the maximum junction temperature to 125°C, maximum ambient temperature will be:

TAmax = 125°C - 72°C = 53 °C

PRINTED CIRCUIT BOARD LAYOUT CONSIDERATION

The ADP3304's proprietary low thermal resistance package significantly enhances its power dissipation capability.

Heat generated on the die is quickly removed and transferred to the PC board. This results a cooler die temperature than the standard SOIC package. The rate in which heat is transferred is directly proportional to the temperature differential between die and PC board. Once heat is transferred to the PC board, it should be dissipated to the air by other mediums.

Surface mount components rely on the conductive traces or pads to transfer heat away from the device. Appropriate PC board layout technique should be used to remove heat from immediate vicinity of the package.

Following general guideline will be helpful when designing a board layout:

1- PC board traces with larger cross section areas will remove more heat. For Optimum results use PC's with thicker copper and or wider traces.

2- Increase the surface area exposed to open air so heat can be removed by convection or forced air flow.

3- Use larger masses such as heat sinks or thermally conductive enclosures to distribute and dissipate the heat.

4- Do not solder mask or silk screen the heat dissipating traces, black Anodizing will significantly improve heat reduction by means of increased radiation.

SHUTDOWN MODE

Applying a TTL high signal to the shut-down pin or tying it to the input pin will turn the output ON. Pulling the shut-down pin down to a TTL low signal or tying it to ground will turn the output OFF. Outputs are independently controlled. In shut-down mode, quiescent current is reduced to much less than 2 µA.

INPUT - OUTPUT DROPOUT VOLTAGE AND DROPOUT DETECTOR

The ADP3304 maintains a regulated output with an input voltage as low as 100 mV above the nominal output voltage. Input voltage falling below this level will generate an error signal indicating that the error amplifier output is reaching its saturated state and will not be able to drive the pass transistor any harder. Lowering the input voltage any further will result in output voltage reduction and loss of regulation.

The input voltage threshold which generates the error output signal depends on the load current. At the rated output current, it is slightly lower than the nominal output voltage plus the dropout voltage. However, the threshold is much lower at lighter loads (see Fig x).

CAPACITOR SELECTION

Input bypass capacitors : Connecting a 0.47µF capacitor from IN pins (pins 5&8) to ground greatly improves its line transient response and reduces the circuits sensitivity to PC board layout. A larger capacitor could be used if line transients of larger duration are expected.

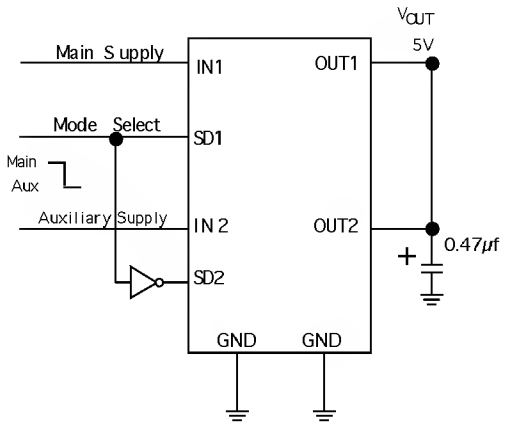
Low ESR capacitors offer better performance on a noisy supply, however, for less demanding requirements, an standard Tantalum capacitor is adequate.

Output capacitors : As with any micropower device, output transient response is a function of the output capacitance. The ADP3304 is extremely stable with wide range of output capacitors and capacitor ESR down to almost negligible ESR. A small 0.47 µF capacitor between the OUT pins (pins 1&4) and ground is needed for stability. For improved transient response, larger capacitors with low ESR is recomended.

For space limited applications, Multi-Layer Ceramic Capacitors (MLCC) are a good choice. For low temperature operations OS-CON capacitors offer better performance.

APPLICATION CIRCUITS

CROSSOVER SWITCH

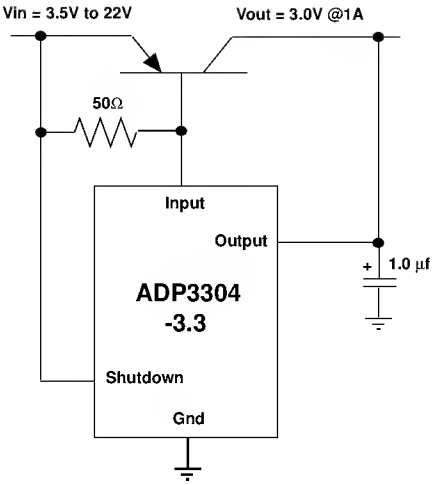


Crossover Switch

HIGHER OUTPUT CURRENT

The ADP3304 can source up to 100ma without any heatsink or pass transistor. If higher currents are needed, an appropriate pass transistor can be used as in figure x to increase the output current.

R1 value can be selected to limit the maximum base current available to the pass transistor thus providing current limiting function.

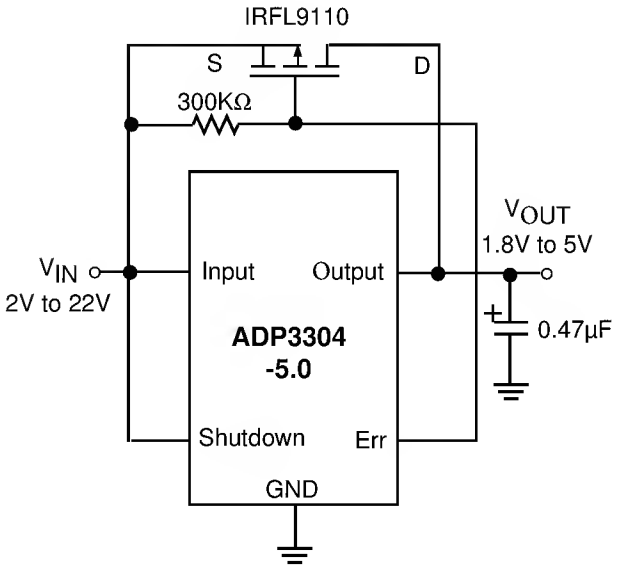


High Output Current Linear Regulator.

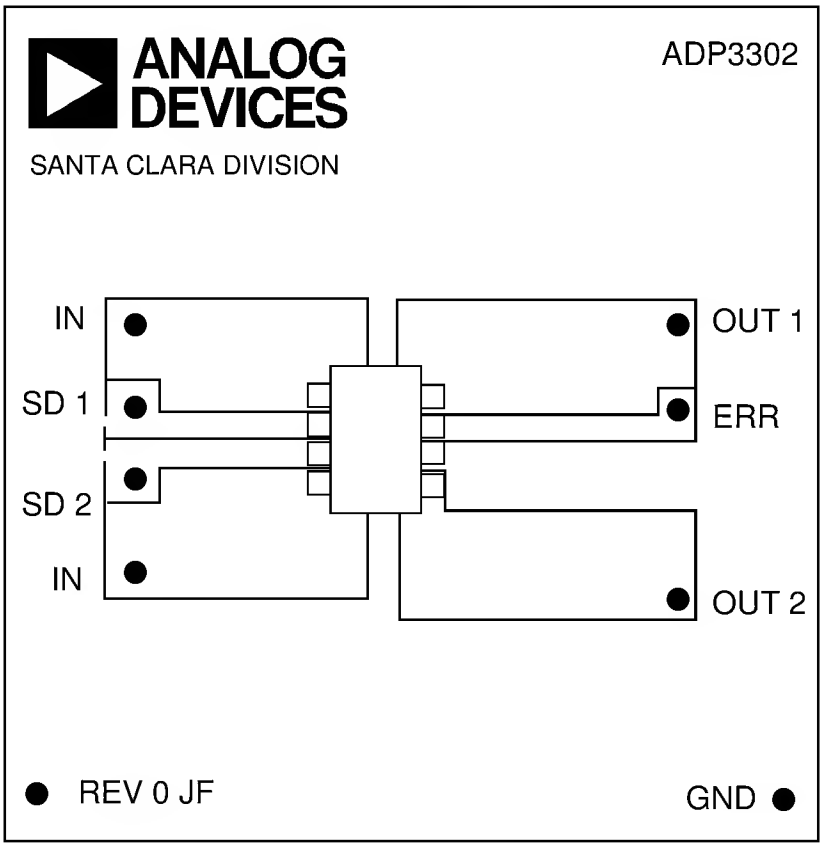
DUAL MODE LDO

The following circuit used in battery operated applications will connect the battery directly to the load when the voltage across the battery drops below the dropout voltage point of the ADP3304 LDO regulator.

This circuit will extend the usable life of the battery in applications where the circuit will operate at a lower voltage than the nominal regualtor output.



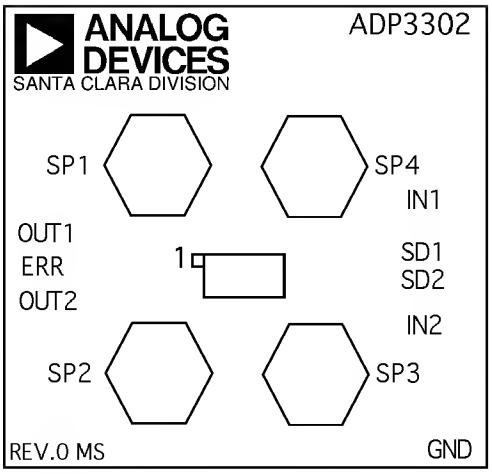
APPLICATIONS



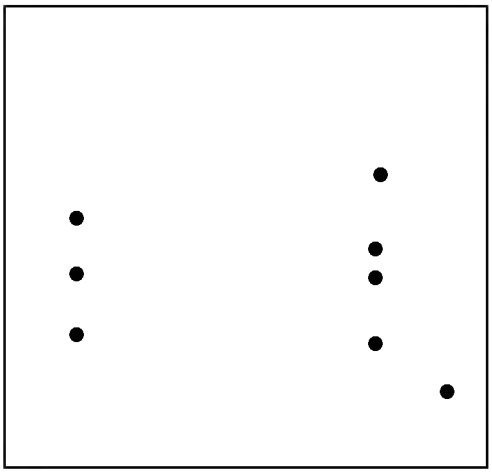
EVALUATION BOARD

CAUTION

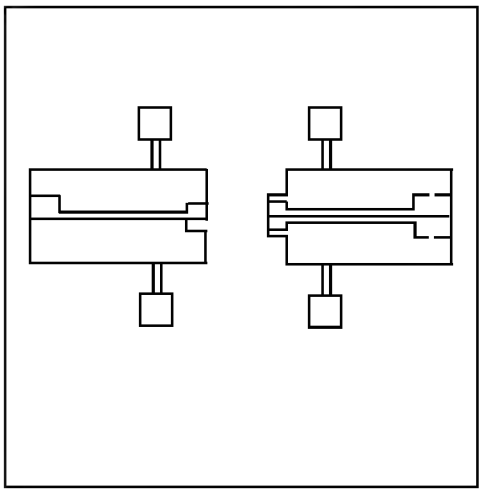
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the ADP3302 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



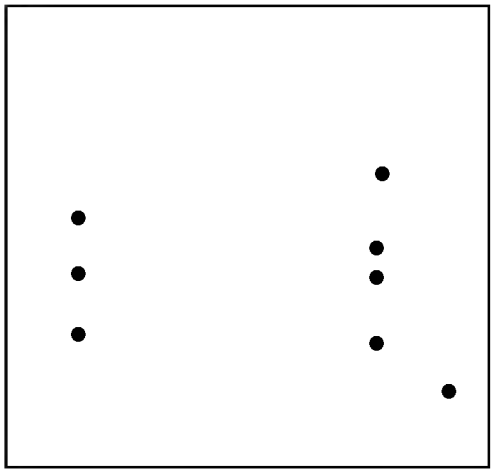
ADP3302 Silk Screen Evaluation Board



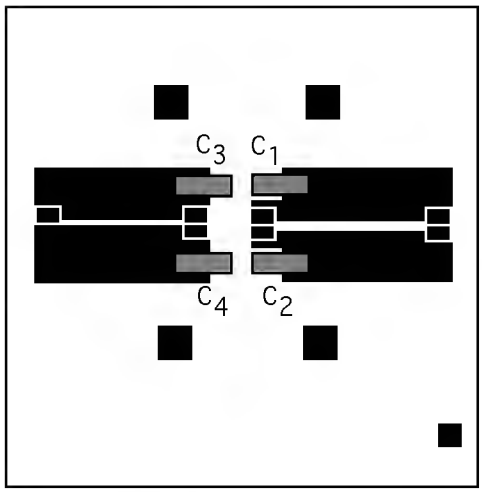
ADP3302 Bottom Layer



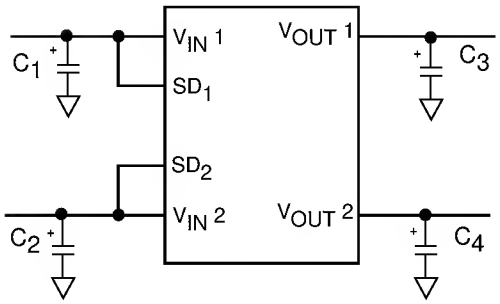
ADP3302 Evaluation Board Layout



ADP3302 Bottom Mask Layer



ADP3302 Component Layout



ADP3302 Evaluation Board Circuit Diagram